



Ministry of the ENVIRONMENT

Artificially Induced Destratification of Valen's Lake

1972

Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

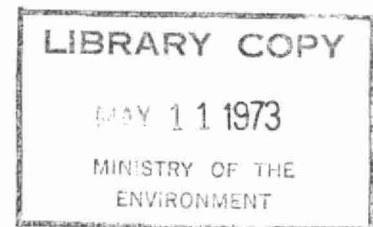
For information on reproducing Government of Ontario works, please contact ServiceOntario Publications at copyright@ontario.ca

Artificially Induced Destratification of

Valen's Lake - 1972

S.E. MacBeth, T.G. Brydges, M.D. Palmer and D.M. Veal

January 1973



LABORATORY & RESEARCH LIBRARY
MINISTRY OF THE ENVIRONMENT

TABLE OF CONTENTS

LIST OF FIGURES.....	ii
LIST OF TABLES.....	ii
INTRODUCTION.....	1
EXPERIMENTAL	
Destratification Equipment.....	3
Flow Measurements.....	4
Chemical and Biological Water Quality.....	4
Sediments.....	6
RESULTS	
Water Flow Measurements.....	6
Chemical and Biological Water Quality.....	9
Dissolved Oxygen.....	9
Mineral Characteristics.....	12
Silica.....	18
Iron.....	18
Nitrogen and Phosphorus.....	18
Chlorophyll - Secchi Disk.....	21
SEDIMENTS	
Sampling.....	22
Chemistry.....	22
Bottom Fauna.....	23
CONCLUSIONS.....	27
RECOMMENDATIONS.....	28
ACKNOWLEDGEMENTS.....	29
REFERENCES.....	30
APPENDIX I.....	31

LIST OF FIGURES

Figure 1	Valen's Lake.....	5
Figure 2	Dissolved Oxygen in the bottom water (percent saturation) with time.....	10
Figure 3	Dissolved Oxygen in the surface water in percent saturation with time.....	11
Figure 4	Dissolved Oxygen differences, surface minus depth in percent saturation.....	13
Figure 5	Seasonal variation in conductivity, $\mu\text{mhos}/\text{cm}^3$, Spencer Creek, at Valens Sideroad.....	14
Figure 6	Conductivity in $\mu\text{mhos}/\text{cm}^3$ in the surface waters.....	15
Figure 7	pH in the surface waters.....	17
Figure 8	Silica, as SiO_2 , in the surface waters.....	19

LIST OF TABLES

TABLE 1	Bubble characteristics, mean vertical velocity, mean vertical turbulence, vertical flow and dye observations for the six diffusers on July 6, 1972.....	7
TABLE 2	Representative Nitrogen and Phosphorus Values in Valen's Lake, 1972.....	20
TABLE 3	Percentage composition of macroinvertebrates in Valen's Lake, 1972.....	25
TABLE 4	List of the macroinvertebrates found in Valen's Lake.....	26

ARTIFICIALLY INDUCED DESTRATIFICATION OF VALENS LAKE 1972

INTRODUCTION

Valens Lake is located on the Niagara Escarpment in the northern portion of Beverly Township. It was formed in 1966 when the Hamilton Conservation Authority dammed the West branch of Spencer Creek North of Highway 97.

This impoundment has a drainage basin of 11 km² (4.2 square miles) and was originally proposed to cover slightly less than 49 hectares (120 acres) and to contain 5.9×10^5 m³ (480 acre-ft) of water for summer stream-flow augmentation and flood control (1). Its primary function, however, has become recreational use. For this purpose the water is maintained at a level 0.61 m (2 feet) higher than that which would yield optimum stream control and contains 12×10^5 m³ (980 acre-ft) of water, covering 61 hectares (150 acres) to a maximum depth of 4.6m (15 feet). This is sufficient water to maintain a flow of 0.11m³/sec (4 c.f.s.) in Spencer Creek for 100 days without additional input if the lake is drawn down to the bottom of the dam (2).

The lake is divided into two sections by some islands (Figure 1)*. The downstream part is about 32 hectares (80 acres)

*Note: All figures and graphs in this report were drawn by machine.

and is the main recreational area. The upstream part is studded with "dead heads" and not amenable to boating. Many fishermen prefer the upper part.

The land which now forms the lake bottom was a mixture of swamp and pasture consisting of a thin layer of neutral to alkaline topsoil over Guelph Dolomite. There were no acid-loving plants growing in the area prior to impoundment (3). No attempt was made to remove topsoil or to steepen the banks around the edge of the future lake. The lake therefore forms an ideal habitat for aquatic weeds, some of which were well established in the swampy areas prior to flooding (3).

Valens Lake is used for swimming, non-power boating and fishing and provides a much needed resource for these activities in the Hamilton area. Extensive growths of aquatic plants and algae now pose a problem which, if not solved will render the lake unsuitable for these activities (4).

The most abundant plants have been Water Milfoil, Coontail, Chara and Pondweed (4). There have been annual increases in aquatic plant growth since the dam was constructed, which is demonstrated by the lowering of water hardness (5). Plants deplete carbon dioxide in the water as they grow and the resulting rise in pH causes calcium carbonate to precipitate thus decreasing water hardness. The May to October average hardness in the stream just below the dam decreased from year to year during the period 1967 to 1971 (5). In the summers of 1969, 1970 and 1971 the swimming area was treated with the Herbicide "Reglone A" to reduce plant growth in that area. Mechanical weed harvesting methods have been tried with limited success.

In the late summer of 1971 an algal bloom of Aphanizomenon occurred which further reduced the attractiveness of the lake (4). Unattractive odours have been noticed at the dam, which at the time was discharging from the bottom of the dam. Conservation Authority

sampling indicated very low oxygen levels, particularly during the fall and winter and it is assumed that the odours were due to sulphides caused by lack of oxygen in the bottom water.

There have been complaints about swimmers itch and an investigation was carried out by the Ministry in 1972 and the results are discussed in Appendix I of this report.

In the winter of 1971-72 The Hamilton Conservation Authority asked the Ministry of the Environment to assist in improving the water quality of Valens Lake. Artificially induced destratification of the downstream part of the lake was recommended by the Ministry in the belief that maintaining an oxygen supply in the bottom waters would improve conditions by:

- 1) eliminating noxious gases produced under anoxic conditions.
- 2) reducing the amount of recycled nutrient phosphorus available to support plant and algae growth.

It has been variously reported (6) that a high oxidizing potential corresponding to oxygenated water increases the affinity of bottom sediments for phosphorus and, conversely, anoxic conditions facilitate the release of phosphorus from sediments. This recommendation was partly based on a report to the New England Regional Commission which demonstrated some reduction in algae in Kezar Lake, New Hampshire by using an air diffuser to mix the lake water (?). Kezar Lake had depth and thermal characteristics similar to Valens Lake and also had similar problems.

Valens Lake is shallow and previous observations indicated no strong thermal stratification. The apparent low oxygen concentrations in the bottom water indicated chemical stratification.

EXPERIMENTAL

Destratification Equipment

Destratification with an air flow was selected as the method to use and six diffusers were installed as shown in Figure 1. Each

diffuser was 6.1 meters (20 feet) long and had 20 holes of 0.4mm (1/64") diameter at 0.3 meter intervals. Air was supplied by a 0.28m³/min (10 c.f.m.), 2 H.P. compressor operating constantly.

Flow Measurements

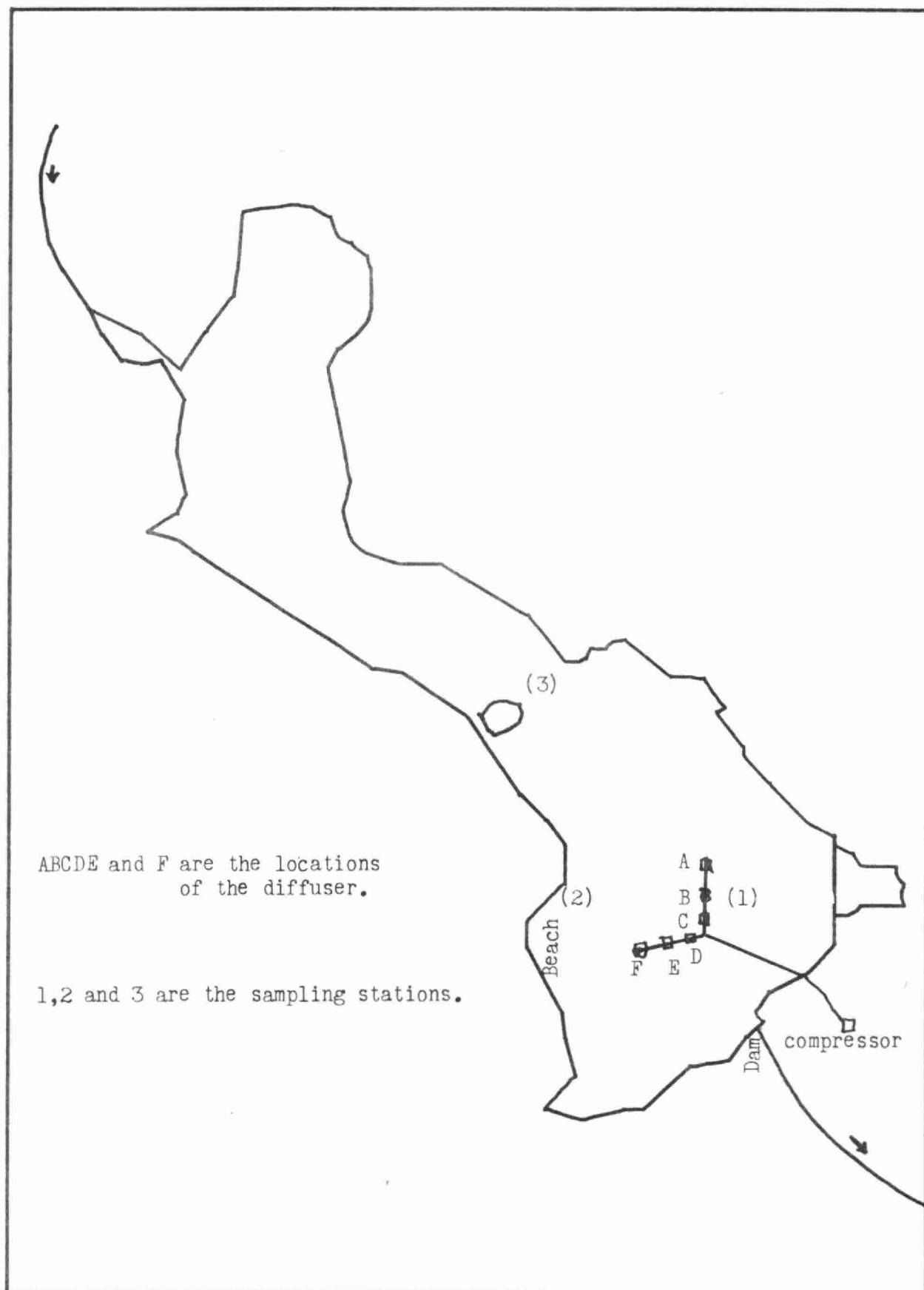
Measurements were made on July 6 to determine the effective mixing due to mass flow of water and turbulence caused by the rising air bubbles. Vertical velocity measurements were made in the vicinity of the air bubbles with a temperature compensated hot film anemometer, (Thermo-Systems Inc., model 1051 with model 1230-W conical probe and model 1310-Y temperature compensator). The film has a 10 Hz response and a 15% accuracy at velocities as low as 1.5 cm/sec. Dye was injected in the region where the bubbles reached the surface to visualize the water movement characteristics.

Chemical and Biological Water Quality

In order to assess the value of destratification, a sampling program was set up by the Hamilton Municipal Laboratories in conjunction with the Ministry.

Three points in the lake were selected for sampling each week at approximately the noon hour. Station 1 is in the deepest location and considered to be within the direct influence of the diffuser. Station 2 is considered less directly influenced by the diffuser. Station 3 is in the upstream shallow part of the lake well removed from the diffusers. There were a total of seven sample points established. Surface samples were taken at each station for algae count, chlorophyll a and chemical analysis. Samples for chlorophyll and chemical analysis were taken at the 1.5m (5 foot) depth at each station and also at the 3m (10 foot) depth at Station 1.

Water transparency measurements were obtained using a Secchi disc. Temperature and dissolved oxygen were measured at all seven sample points. Carbon dioxide, pH, alkalinity, hardness, chloride, chlorophyll and algae count were determined at the Hamilton Municipal Laboratory.



Total and soluble phosphorus, ammonia, Kjeldahl nitrogen, nitrate, nitrite, iron, silica, manganese and conductivity were determined at the Ministry of the Environment Laboratory in Rexdale as well as chlorophyll a for Station 1, surface. All laboratory determinations were performed in accordance with Standard Methods, 13th Edition. Samples were collected for three weeks before the compressor was started on June 26, 1972.

Background water quality information is available for past years from the yearly Sanitary Surveys conducted by the Hamilton Municipal Laboratories and from a Water Quality Monitoring station on Spencer Creek just below the Valens dam sampled by the Ministry. Unfortunately this information is not directly comparable to the 1972 data since the dam discharge was changed from bottom draw to overflow in the spring of 1972.

Sediments

Sediment samples for bottom fauna and chemical analysis were collected in May, June and August.

RESULTS

Water Flow Measurements

The vertical velocity, turbulence and flow, bubble characteristics and dye observations are given in Table I. Velocity measurements were made along three different lines across and perpendicular to the surface bubble section at approximately the quarter points. Measurements were made at various distances from the bubble centreline on either side until a negligible vertical velocity component was detected. Locations of the velocity measurements relative to the surface bubble centreline were determined using rigid measuring sticks and utilizing the rapid response characteristics of the hot film. The mean values in Table 1 represent the integrated mean values on the three different survey lines.

TABLE I

Bubble characteristics, mean vertical velocity, mean vertical turbulence, vertical flow and dye observations for the six diffusers on July 6, 1972.

<u>Diffuser</u>	<u>Diffuser depth (m)</u>	<u>No. of bubble columns</u>	<u>Width of bubbles at the surface (m)</u>	<u>Mean vertical velocity at the center of bubbles cm/sec</u>	<u>Mean vertical turbulence % of the mean velocity</u>	<u>Vertical flow in m³/sec</u>	<u>Dye Observations</u>
A	4.0	19	5.5	12.0	5	0.23	Dye widely dispersed. Initially dye sank then rose to the surface and dispersed evenly in a layer with little evidence of shear layers or turbulence.
B	3.9	-	-	-	-	0.16	-
C	3.7	8	3.5	11.5	15	0.17	Limited dispersion. Dye sank near the diffuser with strong shear layers and turbulence evident.
D	4.1	20	6.0	10.6	10	0.29	Good dispersion. Dye evenly dispersed over the surface.
E	4.3	6	2.0	8.5	30	0.07	Poor dispersion. Dye sank and rose around the diffuser.
F	4.0	8	2.5	11.3	50	0.13	Moderate dispersion with strong cellular motion.
Total Flow						1.05	

In order to have maximum water movement and to allow for maximum exchange of gases between the water and the atmosphere it is desirable to generate a large vertical flow with small turbulence. In this case, water coming up from the bottom tends to spread out as a layer and then slowly sinks. This ideal situation is only possible with a depth density stratification and since there was only a 0.3°C difference between surface and bottom, the effectiveness of the diffusers was considered reduced during the time when these measurements were made.

In spite of less than ideal conditions, there was a displacement of $1.05 \text{ m}^3/\text{sec}$ (37 c.f.s.). At this rate, a volume equal to that of the downstream part of the lake would be displaced in approximately 160 hours or once per week. This represents an estimate since temperature changes with time will affect the displacement rate and it is expected that diurnal heating and cooling will produce temperature differences with depth in excess of 0.3°C .

Not all of the holes were releasing air and it was observed that the number of air streams for a given diffuser frequently changed. The results in Table I reflect the number of air holes functioning. The mass flow is proportional to the number of air holes operating while turbulence is related in an inverse sense. The diffuser with 20 holes operating performed the most efficiently. Changing numbers of operating air streams within the diffuser sections may be beneficial and desirable as it affects different portions of the lake at different times. However, if any of the diffusers is observed to continually have the same few holes operating, cleaning is probably required or it may become necessary to reduce the number of diffuser sections to increase pressure. The latter step should be adopted with caution as a vigorous, easily observed diffuser is not the most effective.

The diffusers were considered to be operating satisfactorily under the conditions of little or no thermal stratification.

Chemical and Biological Water Quality

Water quality at Station 2 generally was identical with Station 1, with exceptions only where noted. Consequently, values for Station 2, where not shown on the accompanying figures, may be considered identical with those for Station 1.

Dissolved Oxygen

It was expected that the most obvious affects of destratification would be on the dissolved oxygen. The concentrations at depths are shown in Figure 2. Some oxygen depletions occurred at Stations 1 and 2 prior to start of the diffuser. It appears that this trend was reversed by the induced mixing and oxygen levels remained high in the bottom water all summer. The bottom draw valves in the dam were opened once each week to flush out debris and the odours observed in previous years were not apparent in 1972. This is taken as evidence of improved oxygen conditions during 1972 over previous years.

The low oxygen value at Station 1, 3m (10 feet) on September 29 was probably due to either or both of two events. There was a dense algae bloom in mid September which may have created a subsequent short term oxygen demand in excess of what destratification could accomodate. In addition, the compressor failed for an unknown period of up to three days between September 14 and 17.

The dissolved oxygen values at Station 3, 1.5m (5 feet) (Figure 2) were erratic, and generally higher than values at Stations 1 and 2, particularly in June and July. During this period the aquatic weeds would be actively growing and releasing oxygen, and since the results represent mid-day conditions they will represent maximum oxygen production.

Surface values for dissolved oxygen (Fig. 3) were also more erratic and higher at station 3 than at stations 1 and 2. The peak values recorded on September 12 were caused by an algae bloom (Aphanizomenon) which reportedly was broken up and dispersed when the diffuser was put back into operation on September 17.

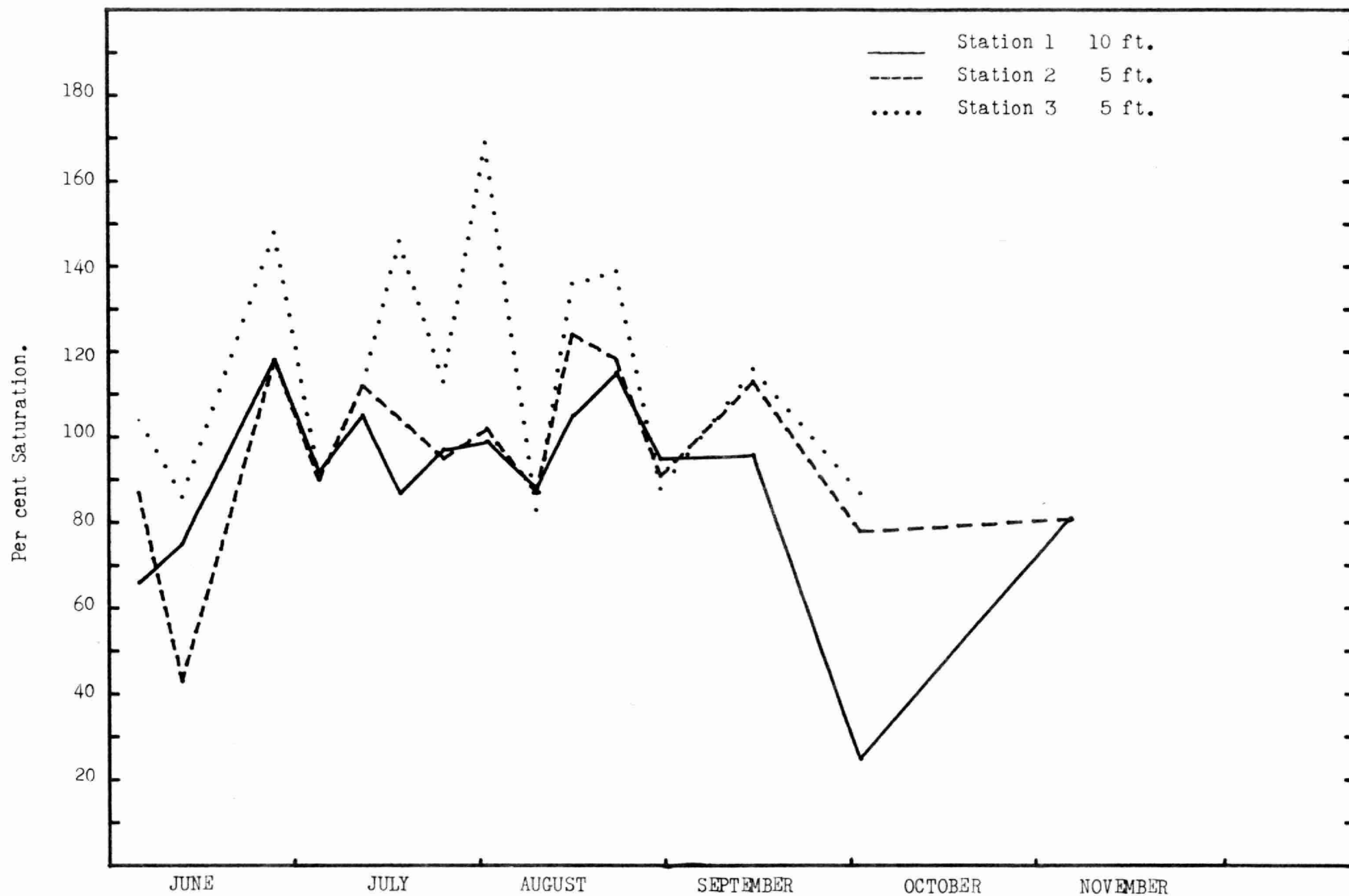


Figure 2. Valens Lake 1972 Dissolved Oxygen in the bottom water (per cent saturation) with time.

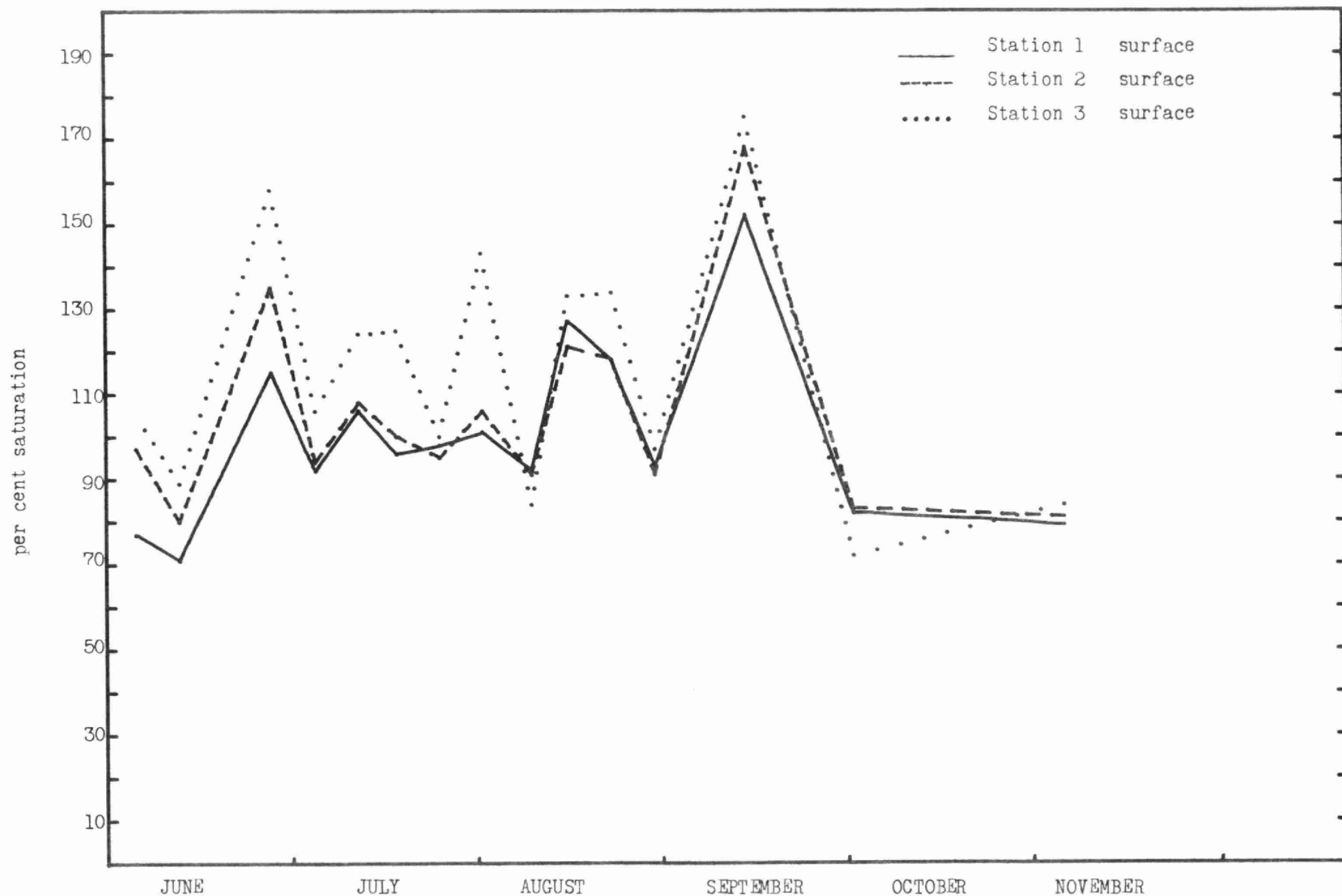


Figure 3 Valens Lake 1972

Dissolved Oxygen, in the surface waters in per cent saturation with time.

Differences between surface and depth values for dissolved oxygen are shown in Figure 4. The depth values were for 1.5 m at Stations 2 and 3 and for 3m at station 1. Again station 3 shows an erratic pattern with higher D.O. at depth than at the surface in some cases. The smaller differences at station 1 and 2 are presumably due to the artificial mixing since the differences in June before destratification started were greater than summer values with one exception. The large differences which occurred on September 12 at all three stations were the result of the algae bloom.

Mineral Characteristics

The principal ionic species in Valens Lake are Ca^{++} , Mg^{++} , HCO_3^- and CO_3^{--} . Minor species such as Na^+ , K^+ , Cl^- and SO_4^{--} showed no variation through the sampling period. For this reason conductivity measurements accurately reflect the changes in hardness and alkalinity which occurred through the sampling period.

The historical and seasonal variations in conductivity in Spencer Creek just below the dam are shown in Figure 5. The data are from the Ministry water quality monitoring surveys. The high winter values are reduced sharply by spring runoff and there have been progressively greater summer decreases due to precipitation of marl by the aquatic plants. The corresponding summer changes in hardness and alkalinity were presented and discussed by Matheson (5).

Conductivity data for Stations 1 and 3 are presented in Figure 6. The pattern is similar to previous years but the minimum value of 271 umhos/cm³ was higher than the 1971 minimum in Spencer Creek of 244 umhos/cm³. After the algae bloom in September, the conductivity increased in a similar manner to previous years.

The changes in conductivity between June and August correspond to hardness changes from 220 mg/l to 150 mg/l with the greatest change at Station 3 where plant growth was heaviest.

A change of 70 mg/l for the entire lake volume corresponds to a minimum loss of 90 tons of marl from the water. This does not

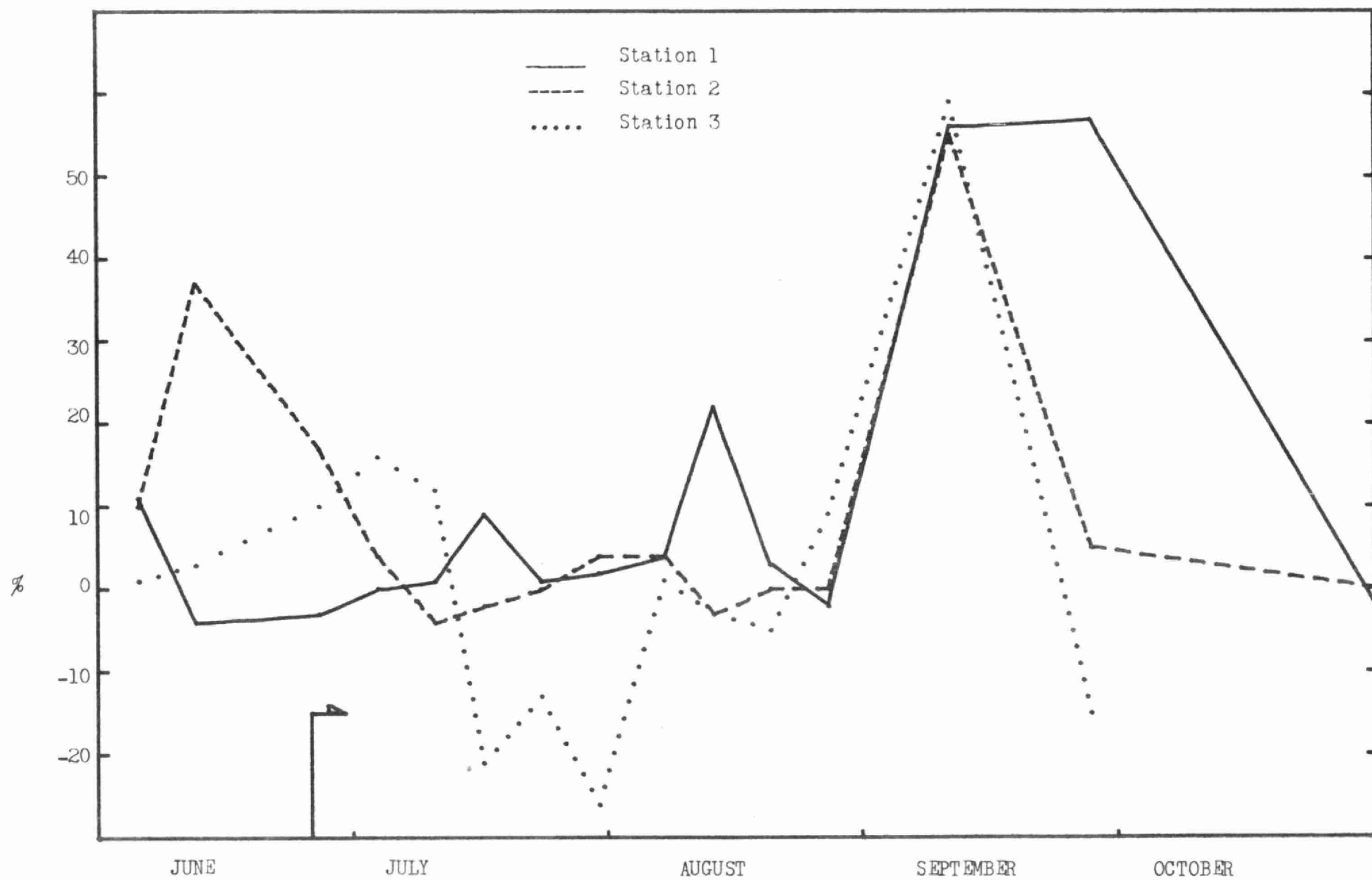
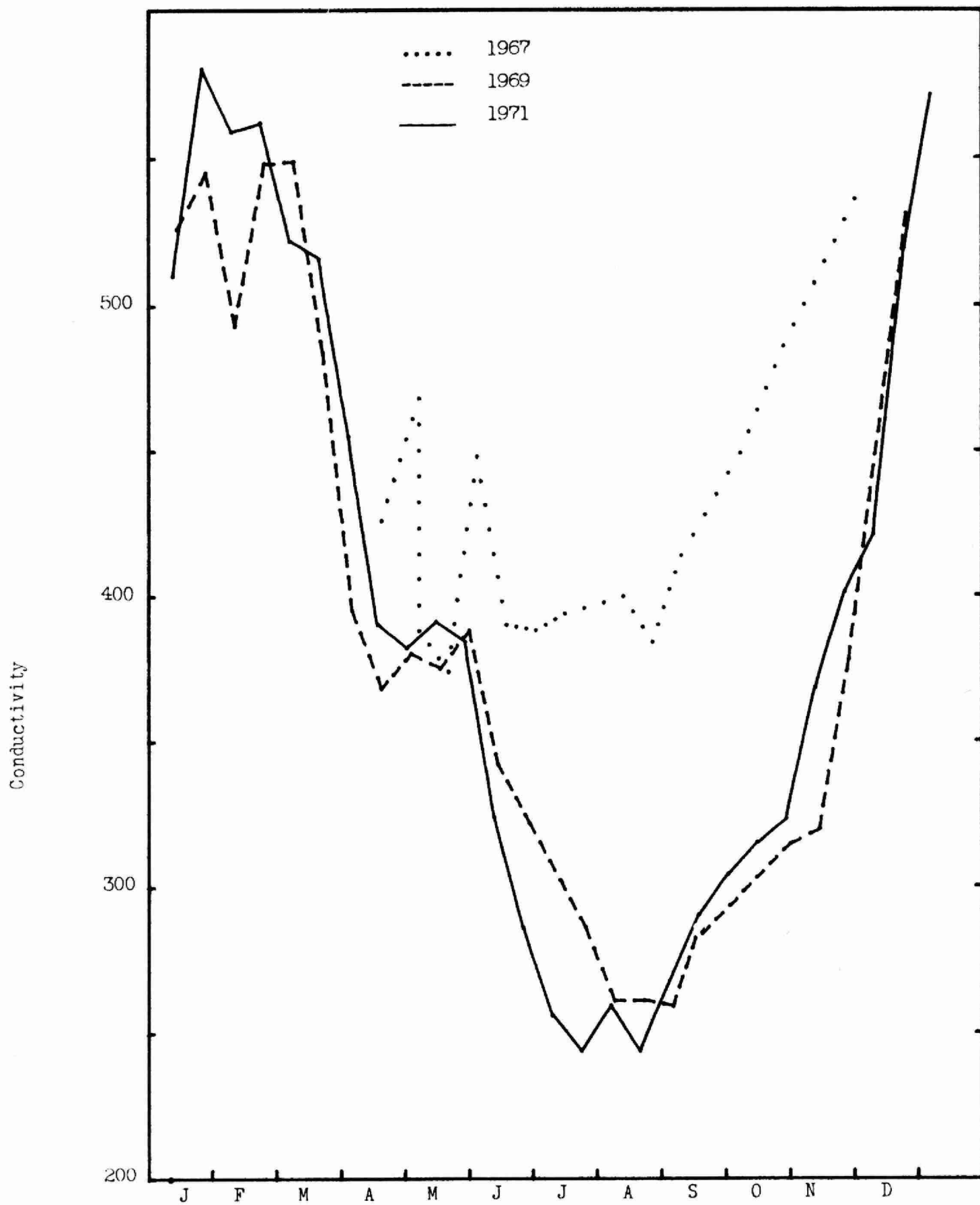


Figure 4 Valens Lake 1972 Dissolved Oxygen differences, surface minus depth in per cent saturation.

Figure 5 Seasonal variations in conductivity, $\mu\text{mhos}/\text{cm}^3$
SPENCER CREEK AT VALENS SIDEROAD.



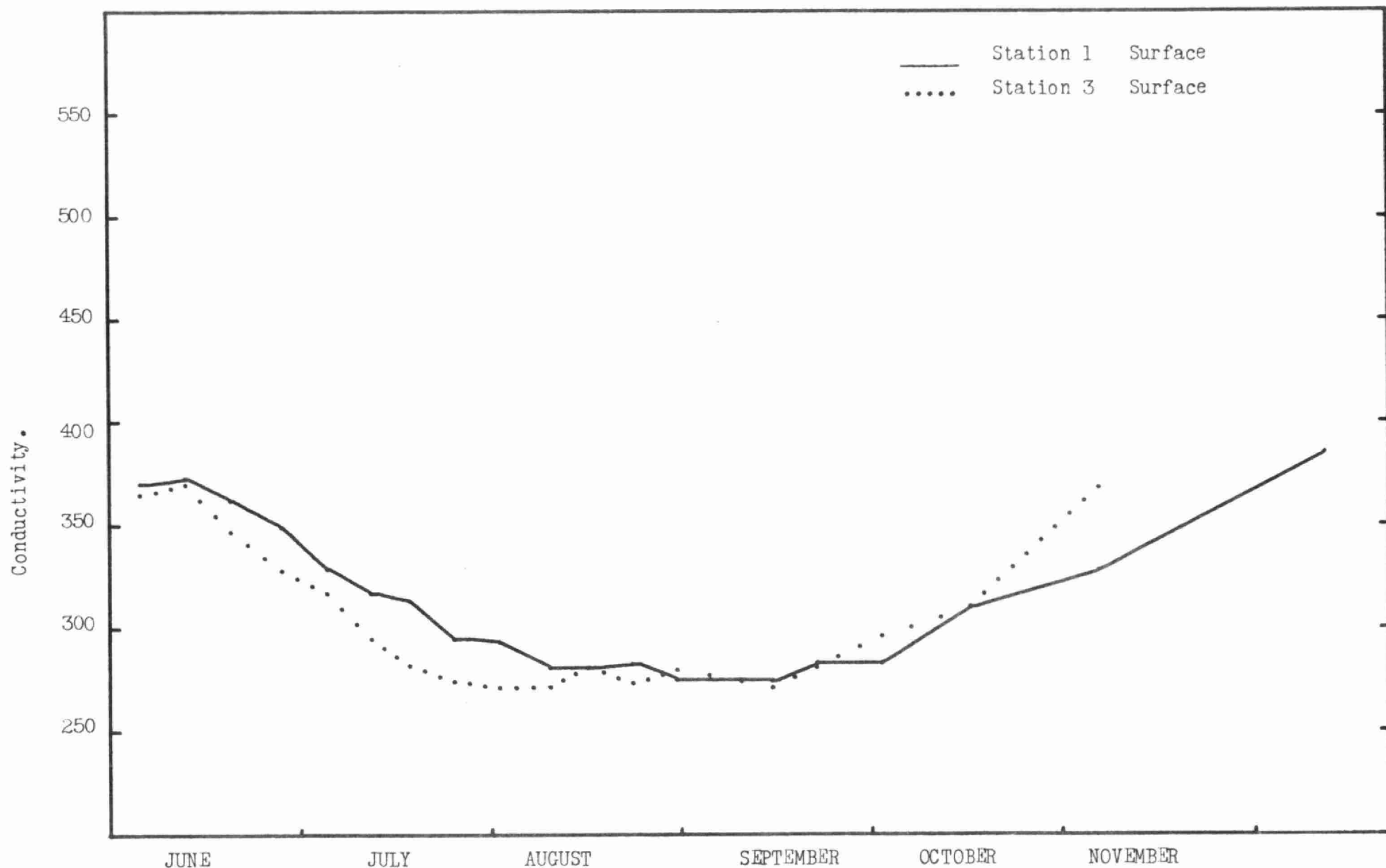


Figure 6. Valens Lake 1972

Conductivity in $\mu\text{mhos}/\text{cm}^3$ in the surface waters.

take into account any additional inputs of calcium carbonate from streams over the summer. Data obtained for chara* in a pond with similar hardness showed an average loss on ignition for 10 samples of 28.7% (I. Wile, private comm.). This corresponds to about 65% marl by weight (8). Therefore, the loss in hardness would estimate a minimum dry weight of plants of 127 metric tons (140 short tons) or about 2.2 metric tons/hectare (1 ton per acre) dry wt. over the entire lake. Wile & McCombie (8) reported a dry weight of 177 gm/m² for growths of 90% chara in the lake mentioned above which corresponds to about 1.8 metric tons/hectare (1600 lbs. per acre). The estimate of 2.2 tons/hectare in Valen's Reservoir, based on changes in hardness alone, appears to be a realistic value. This estimate corresponds to nearly 900 metric tons (1000 short tons) of wet plant material.

As the plants deplete the CO₂ from the water, the pH rises, which ultimately causes the marl to precipitate. The summer values of pH in the surface waters at Station 1 and 3 are shown in Figure 7. The rise in pH was greater at Station 3, particularly in July and early August when the plants would be actively growing. This pattern is similar to that of dissolved oxygen discussed above. The algae bloom in September caused an increase in pH at both stations.

The maximum pH reached was 9.6 at Station 3 on July 24 and 31. At Station 2 it reached 9.5 on July 24 and remained at 9.4 until August 28.

During July and August the pH was consistently above the value of 8.4 recommended as the maximum for water used for swimming. This limit is based on evidence that eye irritation becomes a problem in waters above 8.4.

*Note: Chara was identified as the most common plant in Valens Lake in 1972.

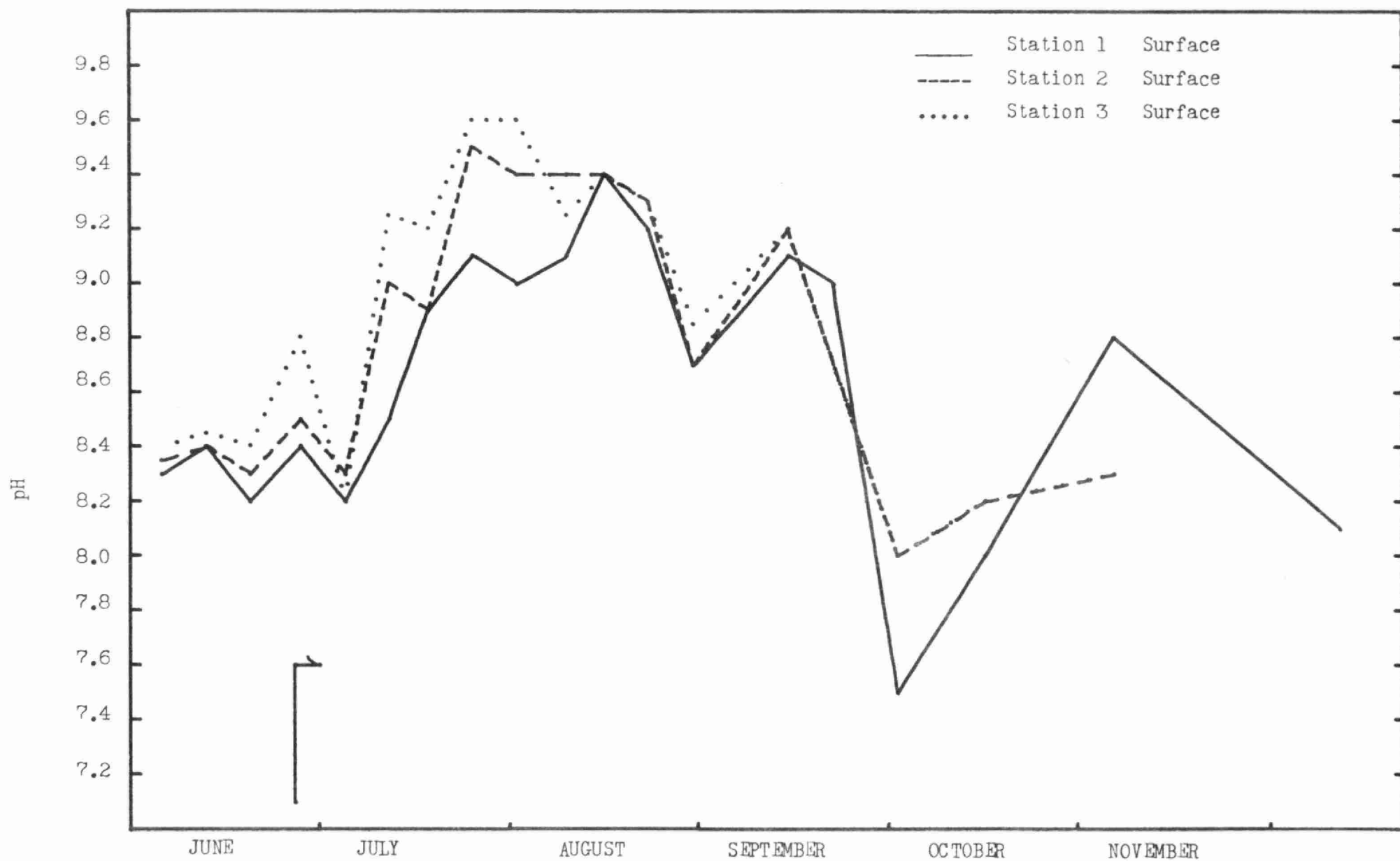


Figure 7 Valens Lake 1972

pH in the surface waters.

Silica

Silica was generally higher at Station 3 but showed an increase at all stations through July from less than 2 mg/l to a peak of 6 mg/l in early August, declining to 3 mg/l in November. This seasonal fluctuation may have been due to dissolution of silica from the sediment under the conditions of high pH. (Figure 8).

Iron

Iron values were low initially at 0.25 to 0.45 mg/l and after destratification began dropped further to 0.10 - 0.20 mg/l. Values increased slightly from September to November. On September 29 a value of 0.85 mg/l was obtained at 10 ft. Station 1. A low oxygen value was observed at this location on that day by the sampler so the sediment may have become anoxic thus releasing some iron and probably phosphorus as indicated below.

Nitrogen and Phosphorus

Ammonia nitrogen and soluble phosphorus were low throughout the summer, ranging from 10 to 100 ug/l N and from 1 to 10 ug/l P respectively. This would be expected in a lake with dense plant growth which takes up available soluble nutrients and the fact that there are no major inputs of soluble nutrients such as sewage treatment effluent. Concentrations were higher by a factor of 10 on September 29 after the algae bloom died off, and presumably was decomposing and then declined to almost summer levels by November. Representative data is given in Table 2.

The nitrate nitrogen concentrations were 10 ug/l or less all summer at all sample points. Concentrations began to rise after the algae bloom died off and reached 310 ug/l by January, Table 2.

Total Phosphorus in the surface samples showed a similar pattern with summer values from 11 to 39 ug/l P. However, the concentration increased in early September, coincident with the algae bloom, when Stations 1, 2 and 3 reached 69, 71 and 120 ug/l P respectively. Concentrations declined to the summer levels by December, Table 2.

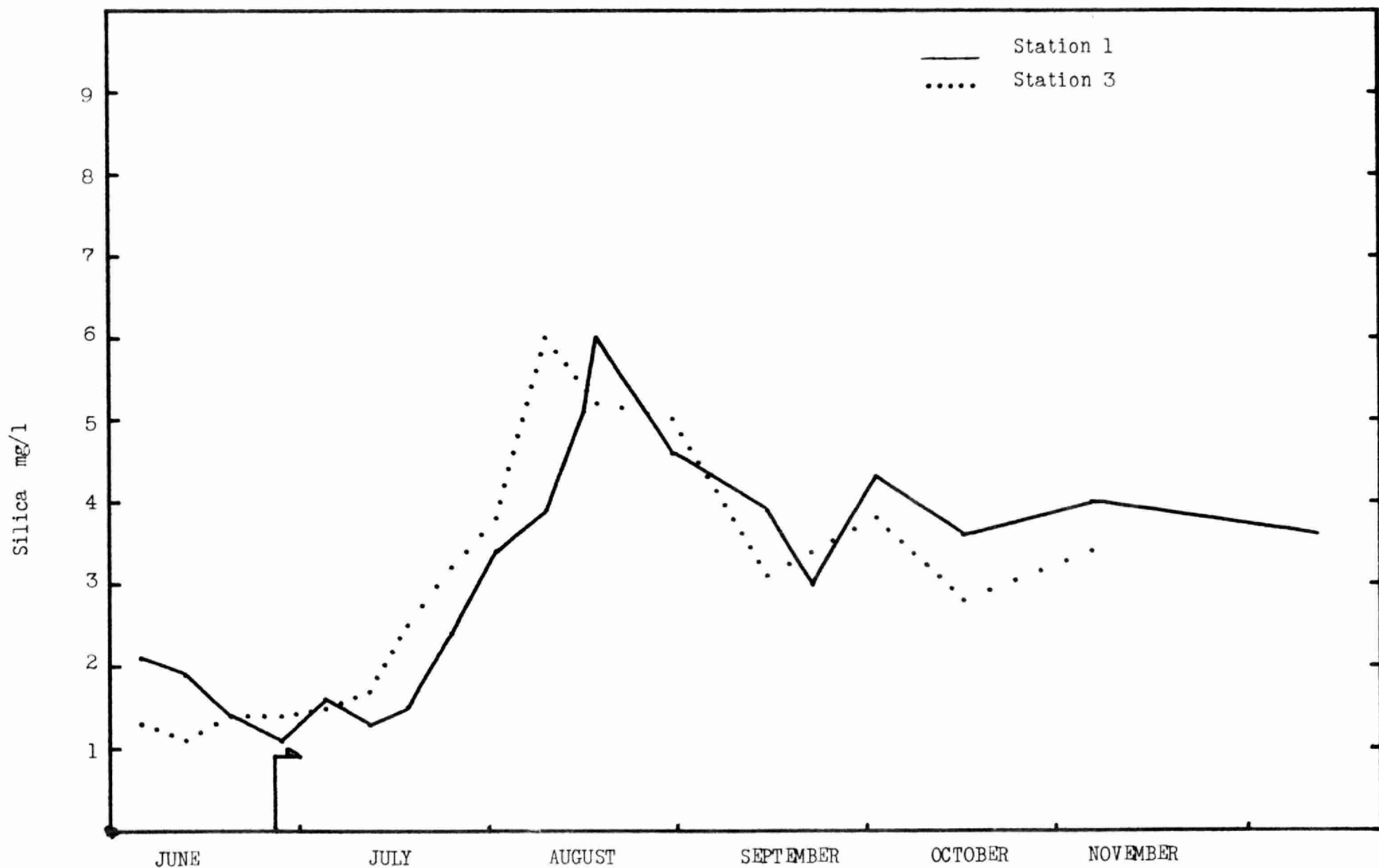


Figure 8. Valens Lake 1972

Silica, as SiO_2 , in the surface waters.

TABLE 2

Representative Nitrogen and Phosphorus Values in Valen's Lake, 1972

Date	Station	Total P $\mu\text{gm/l}$ as P	Soluble P $\mu\text{gm/l}$ as P	NH ₃ $\mu\text{gm/l}$ as N	Total Kjeldahl $\mu\text{gm/l}$ as N	NO ₃ $\mu\text{gm/l}$ as N
June 12	1 surface	24	2	30	780	10
"	2 "	22	1	30	670	10
"	3 "	26	2	30	720	10
July 11	1 Surface	20	2	<10	630	<10
"	2 "	26	1	<10	660	<10
"	3 "	28	8	10	610	<10
August 21	1 Surface	27	4	20	670	<10
"	2 "	28	2	20	710	<10
"	3 "	30	2	20	840	<10
Sept. 12	1 Surface	71	4	10	2000	<10
"	2 "	69	4	10	2300	10
"	3 "	120	3	<10	3900	10
Sept. 29	1 Surface	44	22	280	1100	20
"	2 "	45	18	280	1100	20
"	3 "	38	6	320	1300	30
Oct. 13	1 Surface	44	10	150	1000	90
"	2 "	30	4	110	960	90
"	3 "	31	2	90	940	110
Nov. 2	1 Surface	40	14	130	1000	100
"	2 "	36	2	110	1100	90
"	3 "	25	4	30	590	20
Dec. 7	1 Surface	35	4	270	1200	260
"	3 "	26	3	110	800	210
Jan. 10, 1973	from the spillway, bottom draw	26	4	190	760	310

Depth samples occasionally had higher total phosphorus concentrations than the corresponding surface samples, particularly at Station 1 and they were generally associated with increased iron concentrations suggesting that they were due to regeneration from the sediment.

One of the purposes of destratification was to keep the sediment from becoming anoxic thus preventing recycling of phosphorus. This appears to have generally been the case but in some instances the oxygen supply from water movement was just not enough to keep the sediment surface oxygenated so that some phosphorus probably did recycle.

Kjeldahl Nitrogen ranged from 600 to 900 ug/l through the summer with surface values increasing two to four fold during the algae bloom and reverting to summer values by November.

The increased phosphorus and nitrogen in the water during the algae bloom likely came from decaying aquatic plants. Applying the average concentration changes to the entire lake volume estimates increases of 77 kgm (170 pounds) of phosphorus and 2300 kgm (5000 pounds) of nitrogen. The total amount in the plant material, using the weight estimates from above and the average concentrations for chara (8), would be 300 kgm (650 pounds) of phosphorus and 3200 kgm (7000 pounds) of nitrogen. The calculations show that it is at least numerically possible to explain the nutrient supply for the algae bloom as a consequence of macrophyte decay.

This summer cycle of nitrogen and phosphorus can also be seen in the previous year's monitoring data from Spencer Creek. There is no evident long term trend in the actual concentrations observed since the monitoring station was established in 1967.

Chlorophyll - Secchi disk

The chlorophyll a concentrations in the surface at Station 1 were in the range of 1 to 12 ug/m³ on all sample dates with the

exception of September 12 when a value of 160 $\mu\text{g}/\text{l}$ was recorded during the algae bloom.

The Secchi-disk readings ranged from a maximum of 2.5 meters on July 4 to a minimum of 1.5 meters on August 14 except for September 12 when the algae bloom reduced values to 1, 1.2 and 0.5 meters at Stations 1, 2 and 3 respectively.

SEDIMENTS

Sampling

Three separate grabs were taken with a 23 cm x 23 cm Ekman dredge at Stations 1 and 3 on May 24 and June 19. Two grabs were taken at Station 1 on August 24 but the weed beds at Station 3 were too thick to penetrate with the dredge.

All samples were analysed for nitrogen, phosphorus, loss on ignition, iron and manganese using routine Ministry methods and the bottom fauna were enumerated.

Chemistry

There was considerable variation in each constituent among the three grabs for each station, commonly with a factor of 2 between highest and lowest concentration. Significant changes in chemical composition were not expected, but in view of the large variations observed, it is unlikely that a clear trend would ever be established.

The sediments contained low to medium amounts of organic matter, nitrogen and phosphorus with overall averages of 10% loss on ignition, 4.5 mg/gm nitrogen and 0.9 mg/gm phosphorus.

Iron ranged from 9 to 18 mg/gm and manganese from 0.49 to 1.5 mg/gm .

Bottom fauna

The macroinvertebrates from each sample were separated from the sediments using a brass screen with an aperture size of 0.65 mm. The organisms were hand-picked in a white enamel tray and placed in ethanol for subsequent identification.

Only the macroinvertebrate life in the sediment was investigated and in aquatic environments such as Valen's reservoir, where there is an abundance of macrophytes, many organisms attach themselves to the plants so that an evaluation of the sediment provides information on only part of the faunal population.

Sampling intensity was not sufficient to provide meaningful information on seasonal changes and the difficulties in sampling the weed bed areas precludes most of this type of work. The highly varying chemical nature of the sediments adds to the difficulty in interpreting the faunal numbers and species.

All data obtained from each sampling station has been combined for purposes of discussion.

There was a high density of macroinvertebrates, with averages of 8900 and 7480 organisms per square meter at Stations 1 and 3 respectively. Five "farm" ponds** in the Toronto area with similar depth, biological productivity, size and chemistry had invertebrate densities from 600 to 3700 organisms per square meter.

The high densities in Valen's Lake reflect the high productivity of the lake.

The basic macroinvertebrate community structure in Valen's Lake is given in Table 3. Oligochaete worms and diptera larvae dominated at both stations. Almost all of the oligochaetes which

** Data from these 5 ponds; Bruce, Albion, Hillsburg, Scandrett and Frank, are on file at the Water Quality Branch, Ministry of the Environment.

dominated at Station 1 were sludgeworms and the majority of diptera larvae which dominated at Station 2 were midge-fly larvae. The differences between stations is partially a result of changes in depth and of the abundance of macrophytes. The basic community structure, with worms and midges predominating, was similar to that found in the five farm ponds. A detailed list of the macroinvertebrates found in Valen's Lake is given in Table 4.

The bottom fauna was dominated by organisms generally regarded as pollution tolerant, however, there was a good variety of species including Mayflies which are normally considered to be clean-water organisms which require a constant supply of dissolved oxygen. It is possible that the existing community could have withstood short periods of low oxygen during the summer or prolonged periods during the winter when the metabolic rates of the invertebrates would be minimal.

Table 3

Percentage composition of macroinvertebrates in Valen's Lake, 1972

Organism	Station 1	Station 3
Diptera	20.1	65.2
Oligochaete	67.5	24.4
Mayfly	1.1	4.8
Caddisfly	0	0.14
Leech	10.0	1.7
Mollusc	0.06	1.1
Crustaceans	0.03	1.1
Mite	1.1	1.5
Others	0.06	0.14

Table 4

List of the macroinvertebrates found in Valen's Lake

Oligochaeta	Mollusca
<i>Limnodrilus hoffmeisteri</i>	<i>Sphaerium</i>
<i>claparedeanus</i>	<i>Promentus</i>
<i>Tubifex tubifex</i>	Trichoptera
<i>Uncinails uncinata</i>	Psychomyiidae
<i>Dero</i>	Ephemeroptera
<i>Nais variabilis</i>	<i>Caenis</i>
Diptera	Hirudinea
<i>Palpomyia</i>	(unidentified)
<i>Chironomus</i> s.g. <i>Chironomus</i>	Acari
s.g. <i>Cryptochironomus</i>	(unidentified)
<i>Tanytarsus</i>	Crustacea
<i>Procladius</i>	<i>Hyalella azteca</i>
<i>Cricotopus</i>	Trichladida
<i>Polypedilum</i>	(unidentified)
<i>Ablabesmyia</i>	
<i>Glyptotendipes</i>	
<i>Chaoborus</i>	

CONCLUSIONS

Destratification maintained dissolved oxygen at or near saturation throughout the summer of 1972 and odours associated with bottom draw from the dam in previous years did not occur this year.

The oxygen results and flow measurements indicate that the small compressor was successful in keeping the water in the downstream part of the lake well mixed.

The high pH of the water is a potential cause of eye irritation to swimmers. Reduction of weed growth would reduce the extreme pH values.

The direct influence of destratification on the algae growth is not known, however, algae problems were not serious during July and August as had been the case in previous years.

The short term algae bloom in September appeared to have been supported by nitrogen and phosphorus released by decaying macrophytes, indicating that weed removal would have the direct effect of reducing the nutrient supply and hence the algae growth.

RECOMMENDATIONS

Diffuser operation and monitoring should be continued for at least another year.

Every possible effort should be made to remove large quantities of aquatic weeds. The area involved and type of weeds makes chemical treatment unsuitable and if direct removal proves impracticable then two alternatives could be considered. Firstly, the shore areas in the downstream section of the lake could be dredged and the material used to fill in part of the shallow upstream half. The overall effect would be a greater water volume for a given depth and a greatly reduced area suitable for weeds. Secondly, a review of the art and science of water level manipulation may be of some help.

Acknowledgements

Many people have assisted in this experiment and in the preparation of this report and the authors' are grateful to all who have been involved.

Particular thanks is extended to staff of the Hamilton Region Conservation Authority for their help and cooperation and to the staff of the Hamilton Municipal Laboratories for sample collection and analyses.

Miss Donna McKenzie provided valuable advice and identification of plants and Mr. M. Rawlings prepared the calculator programs required for drawing the graphs and figures.

The Biology Branch of the Ministry also helped by collecting fall and winter samples.

References

- 1) Spencer Creek Conservation Report, 1960. Department of Commerce and Development, Conservation Branch.
- 2) Valens Conservation Area Brochure, Hamilton Region Conservation Authority.
- 3) Mayall, K.M. 1965. "Report to the Hamilton Conservation Authority on conditions prior to flooding Valens Lake".
- 4) Vanderbrug, B.W. 1971. "A report on aquatic weed growth, Valen's Conservation Area", Hamilton Region Conservation Authority.
- 5) Matheson, D.H. 1971. A Sanitary Survey of the Creeks within the Hamilton Region Conservation Authority. Department of Municipal Laboratories, City of Hamilton.
- 6) Stumm, W. and Leckie, J.O. 1970. Phosphate exchange with sediments. Proc. 5th Int. Conf. on Advances in Water Pollution Research. 2 III 26.
- 7) Algae Control By Mixing, 1971. Staff report on Kezar Lake, Sutton, New Hampshire to the New England Regional Commission.
- 8) Wile, Ivanka, and A.M. McCombie, 1972. Growth of Aquatic Plants in Southern Ontario Impoundments in Relation to Phosphorus, Nitrogen and Other Factors. Environment Ontario Report.

Appendix

R.G.V. Boelens

Swimmer's Itch in Valens Lake

Swimmer's Itch, or schistome dermatitis as it is known amongst the medical profession, is a temporary skin infection suffered by bathers who contact the minute larvae of a trematode worm parasitic in waterfowl. During its life-cycle, the parasite multiplies within various species of aquatic snail which serve as secondary hosts for the immature stages of the trematode. The final stage of development within the snail is the cercariae, which is released to the water in large numbers during the months of July and August and which must contact a suitable species of waterfowl if the life-cycle is to be completed. This cycle is interrupted accidentally by the occasional penetration of cercariae into the skin of bathers, resulting in Swimmer's Itch. The rash which results from multiple penetration is not serious but will result in varying degrees of discomfort depending on the susceptibility of the individual; secondary infections occasionally result from excessive rubbing or scratching of the inflamed area.

During the summer of 1972 several reports of skin disorders were received from individuals following use of the swimming area at Valens Lake. Since local health authorities strongly suspected swimmer's itch to be the cause, a brief examination of the snail population was conducted by biologists of the Ministry in August, 1972. It was confirmed that the lake supported an extremely dense population of the snail species Limnaea stagnicola, a recognized host of the 'itch' parasite, and that several specimens examined were moderately infected with cercariae thought to be of the swimmer's itch variety.

Further observations of biological conditions at Valens Lake support the conclusion that an ideal combination of factors exists for the development of a swimmer's itch problem. The shallow, weedy areas of the lake provide ideal habitats for waterfowl; extensive stands of submerged plants, with prolific growths of periphytic algae on the foliage, provide optimum conditions for the growth and development of Limnaea stagnicola, while the existence of a bathing area in proximity to both types of habitat maximizes the potential for a swimmer's itch outbreak.

No easy solution to this problem can be suggested at the present time and, indeed, it seems unlikely that under the conditions described above, any satisfactory solution will ultimately be found. The traditional method of swimmer's itch control, involving the use of molluscicidal chemicals, is not favoured by the Ministry due to inevitable and undesirable side effects to the lake ecology. Chemical treatment over anything less than the entire lake would provide minimal relief since cercariae are readily transported from untreated areas by wind and current action and furthermore, it is considered unlikely that such treatment would be effective for more than a season or two. A major reduction of the submerged weed beds, preferably by mechanical methods, would undoubtedly reduce the available snail habitat but, once again, it is unlikely that complete or lasting control would be achieved in this way.

The only possible solution at the present time seems to be the complete isolation of the swimming facility from the main body of

the lake and the provision of a well filtered water supply. This would be a costly undertaking. Chlorination of the water within the swimming area may pose a problem in view of the elevated pH condition in the lake.

LABORATORY LIBRARY



96936000119609

Date Due

LABORATORY & RESEARCH LIBRARY
MINISTRY OF THE ENVIRONMENT